11/81 P2

ADDENDUM

KAISER TRENTWOOD PLANT
EAST LANDFILL LEACHATE MITIGATION PLAN

BACKGROUND

As a result of Kaiser's review of the above mitigation plan and a 9/23/81 meeting in Spokane, a number of questions have arisen related to site hydrogeology and landfill cover alternatives. These questions were outlined in a 10/27/81 Transmittal Memorandum authorizing Sweet, Edwards & Associates, Inc. to prepare this addendum.

In the following text the issues are listed and followed separately by discussion and evaluation. Refer to the text and figures of the November, 1980 proposed Kaiser-Trentwood Plant East Landfill Leachate Mitigation Plan.

SUMMARY AND RECOMMENDATIONS

Issue 1. Lateral migration of significant moisture from off-site is possible but an extensive boring program to investigate this is not justified at this time. The proposed covered area to the west may be reduced depending upon the results of recommended aerial photo studies. Cost savings from the reduction in covered area could be used to increase the site surface slope and resultant runoff coefficient.

Issue 2. The unfilled portion of Kaiser's pit and the eastern slope should be regraded and covered in a manner similar to that recommended for the rest of the site.

Issue 3. See Table 2 for unit cost comparison of each cover alternative. See text for discussion of suitability of various cover alternatives.

Issue 4. Elimination of the gas venting system from the initial mitigation plan is justified as a cost saving measure. Gas monitors must be installed to determine if significant gas volumes are being generated.

Issue 5. Dry well runoff disposal would be considered as an alternative to conventional drainage ditches because of ditch cleanout costs and safety considerations. The final choice and comparative costs of the two methods are final design considerations.

Issue 6. Additional drilling to evaluate the potential for lateral ground water movement would not be cost effective or justified at this time. As recommended in previous meetings and correspondence however, an upgradient monitoring well is needed to fulfill the requirements of RCRA and Washington Minimum Functional Standards for Solid Waste Disposal Sites. Gas monitoring wells will be needed as described under Issue 4.

Issue 7. Given the solubility of the contaminants, relatively high ground water pore velocities and daily ground water underflow volumes, we can expect to see some reduction in the peak spring contaminant concentrations within one year of completion of the mitigation plan. A significant reduction in the spring contaminant concentration should be realized within two years. The radius of drawdown influence of the plant wells should be determined to see if any other potential contaminant sources could affect the wells, such as the dross staging area.

1. <u>Potential for lateral water movement through dross deposits caused by layers having differing permeabilities, i.e. clay layers or gravel seams.</u>

Based upon data from monitoring wells (MW) 4 and 7, the depth to the potentiometric (water table) surface ranges seasonally from about 75 to 90 feet in the vicinity of the East Landfill. At the location of MW-7 the maximum depth of the waste material is 40 feet. Assuming that the waste profile as shown at MW-7 is typical of the entire site, then the minimum expected seasonal separation between the base of the waste and the water table is about 35 feet. Because of the confining nature of the clayey-gravel stratum at 98 feet in MW-7 and 93 feet in MW-4 the seasonal minimum separation is greater than 35 feet in much of the area.

The above data show that the water table does not seasonally intercept the base of the waste. The primary source of leachate generating moisture is therefore precipitation, including melting snow and ice. The question at issue is how does this moisture enter the waste material? Given the high hydraulic conductivities of existing gravelly surface cover most, if not all, of the moisture input is by direct infiltration through the cover. Reduction of this moisture is the purpose of the Mitigation Plan recommended in the November, 1980 report.

Lateral moisture migration in the unsaturated zone is always possible in layered sediments. This is because horizontal hydraulic conductivity (permeability) is always higher than vertical hydraulic conductivity in layered sediments. The only way to quantitatively evaluate the potential for lateral water movement in the unsaturated zone is through an extensive boring program at the East Landfill. Such a program would include borings drilled on all sides of the site to detect shallow layers of fine grained soils (clays, silts) between the ground surface and the projected base of the waste at 40 feet.

Logs of site monitoring wells MW-1 through 7 (plant production well being MW-6) show the shallowest clayey-gravel layer at a depth of 53 feet (MW-2) and the deepest at 98 feet (MW-7). Although the drilling of all of the plant area monitoring wells showed no fine grained soils shallower than 53 feet, it is possible that such shallow layered sediment could exist adjacent to the East Landfill. However, it is our opinion that this possibility is remote and that the drilling costs for a large number of additional borings are not justified at this time.

We recommend that the cover plan be extended to the north and south property line fences as shown on Figure 1. As a justified cost saving measure we agree with Kaiser that the covered area may be reduced between the landfill and the road to the west.

The amount of covered area necessary could be determined through study of historic aerial photos to confirm the western limit of the waste material.

Cost savings realized from this reduction in covered area could be used to bring in more random fill (see page 10 of November report). This would result in an increase in final slope and a higher runoff coefficient for the final soil cover. The final slope on the Figure 1 conceptual plan was held to 1% to minimize the necessary volume of imported soils and the resultant costs. A final slope of 2 or 3% would be more desirable and cause a higher percentage of site precipitation to leave as runoff. The above changes in the conceptual closeout plan would be part of final site design.

2. Effects to be expected from disposal of material in adjacent pit area.

The site topographic map on Figure 1 shows an approximate ground surface elevation of 2,013 ft. m.s.l. where MW-7 was recently drilled. The waste material was shown to be approximately 40 feet deep at that borehole or at an approximate elevation of 1,973 ft. m.s.l. As shown on Figure 1, the bottom elevations of the unfilled pit to the east range from 1,976 to 1,983 ft. m.s.l. This means that the bottom of the adjacent pit is slightly higher than the base of the waste in the East Landfill. In the conceptual design SEA assumed that the East Landfill waste had been buried at about the same elevation as the adjacent pit.

There is some seasonal ponding of water in the adjacent pit because traffic has compacted the soil and waste material in the pit bottom. Because of these conditions, the adjacent pit acts somewhat as a temporary catch basin. Since the base of the East Landfill is somewhat lower than the adjacent pit bottom, there is some potential for water movement from the adjacent pit bottom through the base of the waste.

The unfilled portion of Kaiser's pit and the eastern slope should be regraded and covered in a manner similar to that recommended for the rest of the site. This would promote runoff toward the east and minimize infiltration of precipitation and ponded water. This was not recommended in the November report because at that time the total depth of the waste in the East Landfill was unknown.

Following grading and covering of the eastern slope and pit bottom, Kaiser could continue filling with inert wastes. Any infiltrating precipitation through this uncovered waste would eventually be perched on the underlying cover and carried downslope to the east and away from the landfill.

With the cover material extended to Kaiser's east property line, it is our opinion that there is little potential for significant western migration of moisture into the East Landfill from the adjacent owner's pit bottom. We have no data on ground water quality to the east and repeat our recommendation that the adjacent owner's well be used as a monitoring well or that a new upgradient monitoring well be installed.

3. <u>Alternatives to the proposed plan and the relative cost effectiveness of each alternative (use of West Coast cost figures). These should include 1' or 2' clay layers (including installation cost), mixing of bentonite with native soil or other soil source, membrane liners, and blacktop (with and without sealers). Should indicate locations where 1' clay layers have been used successfully.</u>

For this item we have evaluated five cover alternatives as follows:

1) 1.5 ft. clay cap + 2.0 ft. soil for final cover.
2) 2.0 ft. clay cap + 2.0 ft. soil for final cover.
3) 2.0 ft. soil/bentonite clay cap + 2.0 ft. soil for final cover.
4) 1.0 ft. soil (or select material base) + 4.0 inches hydraulic asphaltic concrete cap.
5) 36 mil Hypalon Fabric cap + 2.0 ft. soil for final cover.

TABLE 1

CAP AND COVER MATERIAL SPECIFICATIONS

COVER ALTERNATIVE	SPECIFICATION[2]
1. 1.5 ft. clay cap/2.0 ft. soil cover	(a) $K_{clay} = 1 \times 10^{-7}$ cm/sec (b) 2.0 ft. soil cover with 20% moisture holding capacity
2. 2.0 ft. clay cap/2.0 ft. soil cover	Same as Alternative No. 1
3. 2.0 ft. bentonite clay/soil cap + 2.0 ft soil cover	(a) bentonite clay (VOLCLAY) mixed at 5 lbs/ft^2 of covered area using $K_{bentonite} = 1 \times 10^{-7}$ cm/sec (b) 2.0 ft. soil to mix w/VOLCLAY; $K_{soil} = 1 \times 10^{-5}$ cm/sec (c) 2.0 ft. soil cover with 20% moisture holding capacity.
4. 4 inches Hydraulic Asphaltic Concrete underlain by 1.0 ft. soil base	(a) Hydraulic Asphaltic Concrete (A/C) using dense graded aggregate ¼" maximum and $K_{A/C} = 2 \times 10^{-8}$ cm/sec (manufactured as a hot mix)
5. Hypalon + 2.0 ft. soil cover	(a) Hypalon is 36 mil thick with 10" x 10" reinforced scrim (b) 2.0 ft. soil cover with 20% moisture holding capacity

NOTE:

1. K = hydraulic conductivity (permeability)
2. Specifications listed above may be modified based upon availability in Spokane area.

The above alternatives assume that random soil fill has been used as a base material to grade the site to the desired slope. General specifications and unit costs were obtained from Chuck Kemper with R. A. Wright, Engineers. The material specifications in Table 1 were used to derive unit costs for each cover alternative.

The above listed general specifications were used to develop a unit cost for each alternative. This is the estimated cost to install each cover system alternative per square foot of covered area. It was decided to use a unit cost/square foot instead of total cost because the covered area may be modified as discussed under Issue. Nos. 1 and 2.

The unit costs listed in Table 2 are nearly the same except for the Hydraulic A/C which is significantly higher than the other cover alternatives. Remember that these are based upon West Coast (Portland) prices and that material availability, haul distances and construction costs in the Spokane area will be different than those in Portland. Therefore these unit prices should be used only for general comparison between the cover alternatives.

We are not endorsing Hypalon as a solely suitable membrane for this application. There are over one hundred types of membranes on the market and the final choice would be a design decision based upon availability and compatability with the East Landfill

TABLE 2

UNIT COST COMPARISON

COVER ALTERNATIVE	UNIT COST PER SQUARE FOOT OF COVERED AREA
1) 1.5 ft. clay cap + 2.0 ft. soil cover	$0.91/ft^2
2) 2.0 ft. clay cap + 2.0 ft. soil cover	$1.09/ft^2
3) 2.0 ft. bentonite clay/soil cap + 2.0 ft. soil cover	$1.17/ft^2
4) 4 inch Hydraulic A/C underlain by 1.0 ft. soil base	$1.34/ft^2
5) Hypalon + 2.0 ft. soil cover	$1.11/ft^2

wastes and gases, if any are generated. There are also other retailers of bentonite clay and other types of asphaltic sealers. We used these brands and mixes for the purpose of developing comparison costs, and they have not been evaluated for suitability or use at the East Landfill.

Since the unit costs fall within a narrow range, the choice of cover options should be based primarily on the suitability of these various methods for use at the East Landfill. The primary advantage of the hydraulic A/C and Hypalon are their very low hydraulic conductivity if properly installed. However, these materials are generally used as bottom liners and not covers. A major concern with these materials is repair of the cover following differential settling of the waste material. With a 1 to 3% surface slope, minor differential settlement will cause ponding on the cover surface. Repair of membrane or asphaltic sealers would be much more expensive than repair of a clay/soil cover. It would not be practical to install a gas venting system through a membrane or asphaltic cover. This is because membrane and asphaltic materials are more difficult to breach and effectively reseal than clay/soil covers. Therefore, if Kaiser wants to forego the gas venting system until necessary then a clay/soil or bentonite/soil cover should be used. More discussion of the gas venting option follows under Issue No. 4.

In choosing the type of cover material, it should be remembered that the majority of solid waste sites in the U.S. are installed with clay or soil covers. Some nationwide performance evaluations of covers have been attempted, however, such evaluations are technically difficult to make and site owners are understandably reluctant to have them made. There are no comprehensive nationwide studies of cover performance available. However, as discussed previously, we are looking forward to showing you several operating landfills in the Willamette Valley which use soil covers. It should be noted that many of the membrane and other alternative manufactured cover types have not been in use very many years. However, several EPA funded studies have been conducted dealing with compatability of these manufactured materials to different waste types and weathering.

For this cost analysis we chose to use 1.5 feet as the minimum thickness of clay cap. We previously recommended a 1.0 foot thick clay cap to minimize clay borrow and construction costs. We still feel that a 1.0 foot thick cap is suitable, however construction quality control is such that specifying a 1.5 feet thick clay cap should assure that the in-place clay will be everywhere at least 1.0 foot thick. Regardless of clay thickness it should be remembered that the capillary force of water in clay will prevent downward water movement into coarser grained base soil. The moisture will tend to move laterally toward the edges of the cover instead of downward until the hydraulic head overcomes the capillary force in clay. This mechanism of moisture barrier is not available in a membrane cover which depends solely on liner integrity to block moisture movement.

4. Recommend whether gas venting system should be installed initially or added at a later date if necessary.

Waste in the Heglar Kronquist site has historically produced gas which needed venting because it broke through the soil cover. However, the Heglar Kronquist site was not covered in the manner we recommend for the East Landfill and we understand that the dross wastes are not as concentrated in the East Landfill as they are at Heglar Kronquist. If gas has been historically produced at the East Landfill it has moved easily through the coarse grained soil cover.

The improved moisture routing plan proposed for the East Landfill will prevent significant volumes of gas producing moisture from entering the waste. As a cost saving measure we therefore recommend that the proposed gas venting system not be installed as part of the initial mitigation plan. Gas monitors must be installed however, to determine if significant gas volumes are being generated. These monitors would consist of at least one well near the center of the covered area and several wells spaced along the edge of the covered area. If significant volumes of gases are generated at the site, then a venting system must be installed through the cover material to protect cover integrity and adjacent property.

Note that eliminating the gas venting system from the mitigation plan would not be practical if a non-soil cover were used. As discussed under Issue No. 3 it would not be practical to install a gas venting system with connected laterals through a membrane or asphaltic cover. This is because re-sealing these cover types along the lateral lines against moisture would be prohibitively expensive and possibly not effective. The only practical type of gas venting system which could be installed through a non-soil cover would consist of individual vents not connected by lateral collectors. This type of venting system is not as effective as one with lateral collectors, therefore a clay/soil type of cover is recommended if the gas venting system is to be dropped from the mitigation plan.

5. Discuss alternatives to proposed runoff disposal plan considering suitability and cost.

The simplest runoff disposal method is simply a lined drainage ditch similar to that shown on Figure 1. However, given the recommended cover surface slopes this ditch will be several feet deep at the street. The actual ditch depth will depend upon final design. A French drain or dry well type of runoff disposal was presented as an option because of cleanout and safety considerations.

At low ditch grades of 1% as originally suggested, there will be some maintenance required for removing sediment from the drainage ditches. A manhole type settling basin or overland flow through grass could be used in conjunction with a dry well to remove sediment. These methods of sediment removal from storm runoff may be more cost effective than periodic cleaning of drainage ditches.

If the drainage ditches are more than several feet deep at the street, there will be the matter of safety to consider. A fence could be constructed between the road and the edge of the ditch.

The use of dry wells would remove the need for ditch cleanout and safety considerations. Spokane County has strict requirements for treatment of runoff prior to disposal in dry wells. This pretreatment requirement is due to the sole source aquifer designation. Standard pretreatment consists of routing the storm runoff over a grassy area to remove a designated percentage of such potential contaminants as suspended solids, dissolved solids, nutrients (Nitrogen, phosphorous), metals, organic chemicals and bacteria. The County is open to other methods of pretreatment if their suitability can be demonstrated.

The above discussion was presented to point out that the runoff disposal method is a matter subject to final design.

Comparative costs for alternative methods of runoff disposal are also a final design consideration.

6. Indicate whether additional monitoring wells are necessary.

Some discussion regarding additional drilling to evaluate the potential for lateral movement of ground water was presented in Issue No. 1. We do not feel that such drilling would be cost effective or justified at this time. In the remote chance that the proposed moisture routing plan does not reduce ground water contaminant levels as anticipated, then additional exploratory type drilling and monitoring well installation would be justified.

As recommended in previous meetings and correspondence an upgradient monitoring well is needed at the East Landfill. If Kaiser does not wish to use the off-site well in the adjacent pit then a new monitoring well should be drilled at the eastern property line. This well could be drilled in the unfilled area and the surface riser pipe raised in sections as the area is filled. An upgradient monitoring well is required by RCRA and by Washington Minimum Functional Standards for Solid Waste Disposal Sites. Upgradient ground water quality data are needed to determine if off-site contaminant sources are affecting ground water quality at the Kaiser plant. This new monitoring well might also indicate whether significant moisture is moving from the adjacent open pit into the East Landfill waste.

Gas monitoring wells will be needed as described under Issue No. 4. The number and placement of gas monitoring wells is a matter of final design.

7. Discuss the time required to significantly reduce contamination at Trentwood's production wells if one of the above schemes are implemented.

The goal of the cover and moisture routing mitigation plan is to prevent infiltrating precipitation from moving through the waste material. Historically, the infiltrating moisture has moved from the surface through the waste carrying contaminants in solution through the underlying unsaturated zone to the water table. By preventing moisture input from the surface the mitigation plan will remove the primary source of leachate producing water. After construction of the engineered cover has been completed, the main contaminant sources will be the precipitated salts and other compounds in the zone of seasonal water table fluctuation.

Based upon the 1979/80 hydrograph for MW-4 immediately west of the East Landfill the average seasonal water table fluctuation is approximately 15 feet. The period of high water table approximately coincides with maximum precipitation recharge from the surface and with the peak concentrations of chloride and nitrate (see Figure 9, page 14, Trentwood Plan Monitoring Well Data Evaluation, August, 1980).

Given the high transmissivity of the aquifer, e.g. $T = 2.5 \times 10^6$ ft^2/day and reported ground water pore velocities of 60 to 90 ft/day, there is a great potential for contaminant dilution during periods of low water table levels. For example, given the above transmissivity, an average ground water gradient through the plant area of 0.0007 to .001 ft/ft; and a unit aquifer width of 500 feet; i.e., the approximate width of the East Landfill, would transmit approximately 1.25 million gal/day of ground water underflow. This underflow occurs essentially continuously at the low water table elevations in the aquifer, and should provide very rapid dilution.

The zone of seasonal water table fluctuation however, receives only temporary flushing depending upon the maximum spring water table elevation and the duration of the high water table. This zone does not receive continuous dilution by ground water underflow and more time will be required to completely flush the precipitated salts from this portion of the seasonally unsaturated zone.

Judging from site ground water quality data gathered to date, the lower or perennially saturated portions of the water table are completely flushed on an annual basis. A quantitative estimate of the time required to completely flush the zone of water table fluctuation would require an analytical model of the solute/mass transport equation. Such an analysis would require further laboratory leachability tests, such as were run on the samples from MW-7. It would also require additional well drilling to further define the lateral extent and thickness of the contaminated portion of the unsaturated zone.

Given the solubility of the contaminants, relatively high ground water pore velocities and daily underflow volumes, we can expect to see some reduction in the peak spring contaminant concentrations within one year of completion of the mitigation plan. A significant reduction in the peak spring contaminant concentration should be realized within two years.

An important assumption in this qualitative analysis is that the future seasonal water table fluctuations are average. If, for example, the spring high water table fluctuation in 1985 was 10 feet higher than normal then we could expect to see a contaminant slug move through the system due to leaching in a zone not saturated since the mitigation plan was completed.

At this point, we repeat our earlier recommendation that the radius of influence of the plant wells be determined. This could easily be done because only one of the wells operates at a time and they are both equipped with air lines which are used to measure the depth to the water table. This should be done to determine if any other potential contaminant sources could affect the wells, such as the dross staging area.